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Service Integration for Improved Diabetic and Dental Care: Exploring an Effective Model for Optimising Health Outcomes

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Abstract

This study identifies and synthesizes existing literature on the integration of diabetic and dental services and explores a service integration model for optimising diabetic patient health outcomes and improving healthcare systems in low and middle-income countries. Peer-reviewed literature that analysed the integration of health services regarding dental and medical services were reviewed. The articles were identified using the Academic Search Complete, Business Source Complete, CINAHL Complete, Google scholar and MEDLINE databases and screened using the PRISMA guidelines. A total of 40 full-text articles were examined for eligibility out of which 26 were selected for analysis. Diabetes was shown to contribute significantly to global disease burden, and this is also reflected in most low- to middle-income countries. It is found that the integration of medical and dental services could help alleviate this burden. Hence, locally adapted Rainbow-Modified Integrated Care model is proposed to fill this integration gap. The integration of dental and medical services has been proven to be useful in improving diabetic patient outcomes. Hence, the need to facilitate cross-professional collaboration between dentists and physicians cannot be overemphasised and this can be extended and locally adapted by different health systems across the world. The integration of dental and diabetic services using models such as the Rainbow Model of Integrated Care is recommended to optimise health outcomes of diabetic patients and enhancing service delivery, especially in resource-poor healthcare systems.

Keywords: Diabetes, Dentistry, Service integration, Healthcare system, low and middle-income countries

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Introduction

There has been a global epidemiological transition of diseases from communicable to non-communicable diseases. This generally reflects the global social development with its attendant increased life expectancy, which is however plagued by poor dietary habits and inadequate physical activity. The mounting burden of non-communicable diseases especially in low- to middle-income countries also highlights the impact of globalisation and urbanisation on this epidemiological shift.

Diabetes Mellitus (DM), a chronic non-communicable disease that causes blood sugar levels to be higher than normal, is reported to cause about 4% of global deaths annually (Pei, 2015, p.1). The International Diabetes Federation (2012) in providing a perspective estimates that this disease affects about 400 million worldwide. In the United Kingdom, diabetes is the most common pre-existing medical condition that complicates the outcomes of pregnancy (Bick et al., 2014). A review of Australia's disease profile also shows that type 2 Diabetes features prominently among the national disease burden, resulting in over $14 billion direct and indirect healthcare costs annually, in addition to reducing life expectancy by about five years (Furler et al., 2014, p. 2). In the USA, DM has achieved epidemic proportions with 8.3% of the population, representing 25.5 million people, living with DM (Glurich et al., 2013, p. 2). Perhaps, the impact highlighted above is made clearer by Poudel et al (2017, p. 267) estimate of the global healthcare cost of DM to be more than $673 billion, and this paints a gloomy picture of the extent to which this disease poses a burden globally. It is therefore unsurprising that global efforts have been directed at reducing the burden of this disease.

In this regard, both medical and dental literature have linked diabetes with periodontitis, a disease that results in the irreversible loss of supporting tooth structure (Ng et al., 2014; Balu, 2007; Wang et al., 2009). This finding is supported by Lalla & Papapanou (2011), Mealey & Oates (2006) and Prenshaw et al. (2012) who further explain that this link is bidirectional, that is, patients with diabetes have an increased risk of developing periodontitis, while patients with periodontitis also have an increased risk of developing complications from diabetes. That is, diabetic patients who undergo regular periodontal therapy can reduce HbA1c (an indicator of blood sugar control) from about 0.27% to 1.03%, which means such patients may not require a second diabetic medication

(Ismaeil & Ali, 2013; Eldarrat, 2011, Sanz et al., 2018). Thus, patients are encouraged to periodically visit the dentist for periodontal therapy in order to improve their general health.

In 2007, the Executive Board of the WHO while acknowledging the intrinsic link between oral health and general health recommended an action plan for health promotion and disease prevention that targets both diseases (WHO, 2007). This plan included an integrated approach that seeks to address oral diseases and chronic diseases that have common risk factors. This has informed changes where some health systems (e.g. NHS England) recommend signposting all diabetic patients to see a general dental practitioner. The American Diabetes Association (2018) also published guidelines for the management of diabetic patients which recommends an annual oral examination for every diabetic patient. However, these periodic inter-departmental visits could be made more effective with the presence of an integrated referral pathway between the diabetic and dental clinics, a service currently unavailable within most healthcare systems. Hence, the solution here lies in the provision of integrated care; the systematic coordination of medical and dental healthcare professionals, which is expected to empower patients to make informed decisions about the utilisation of health service rendered at the dental and diabetic clinics. This is not only affordable but also technically possible, ethical and efficacious.

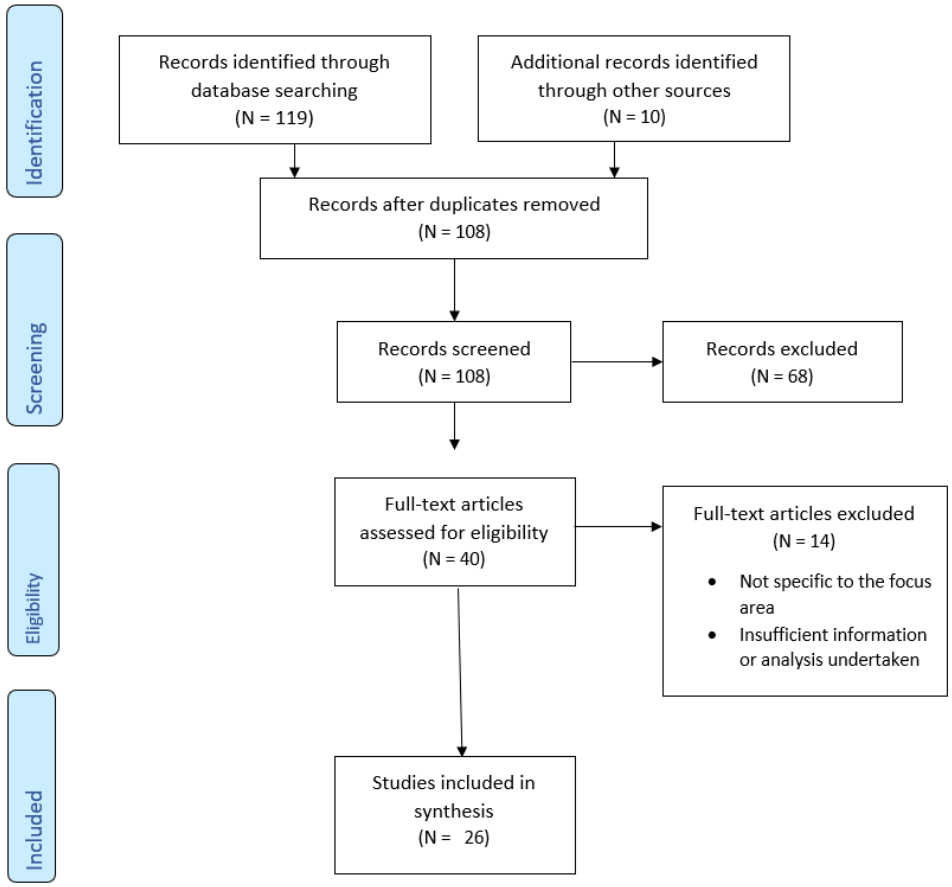
Yet, there is a paucity of evidence-based analysis in the literature on the integration of medical and dental services and its application to health systems especially in low- to middle-income countries. Therefore, this study aim to identify existing integrated models and explore the feasibility of introducing integration services to healthcare systems especially in low- to middle-income countries. This would enable policymakers, healthcare managers, international health organisations, professional bodies, the ministries of health, local health agencies and other key stakeholders make informed decisions on health service delivery pathways. Therefore, the objectives of this article are to critically appraise the literature regarding the integration of diabetic and dental services and to identify integrated care models that can be applied to the healthcare systems in some low- to middle-income countries for improving patient outcome and efficient service delivery and achieving organisational effectiveness.

Methodology

A systematic review research design was adopted in this study with an initial scoping review of the literature to get an appreciation of the academic scholarship pertaining to medical and dental integration. A literature search from five databases including Academic Search Complete, Business Source Complete, CINAHL Complete, Google scholar and MEDLINE was conducted using the EBSCO Host platform and these specific databases were chosen because they allowed the targeted searching of subject areas relevant for this study. The keywords and alternative search term used include ‘integrated care’, ‘collaboration’, ‘multi-disciplinary’, ‘integrated approach’, ‘health outcomes’, ‘patient outcomes’, ‘quality of care’, ‘Diabet*’, 'medical and dental', 'oral and systemic', 'medical and oral' and 'physician and dentist'. The Boolean operators used were ‘AND’ and ‘OR’. Additional articles were also identified through citation tracking. The articles were then screened using abstract and titles to identify articles relevant to this literature review. Finally, full articles were then reviewed for eligibility and appraised using the CASP appraisal tool (see Fig 1). This appraisal involved a non-scoring system that primarily used three broad issues to assess whether the results of the studies are valid, what the results are and if the results will help locally (see the data extraction table). The careful reading of the selected articles enabled the identification of some central themes, which were structured under the relevant topics in order to methodically explore the identified themes.

Furthermore, the identified integrated care model suitable for applicable to the healthcare systems of some low- to middle-income countries in sub-Saharan was assessed using the RE-AIM Framework which helped identify contextual nuances critical to integrated healthcare in these countries.

Fig 1: Summary of literature search method using a PRISMA flow diagram



Results

A total of 119 articles were generated using all the search terms, that is, Academic Search Complete (61), MEDLINE (15), CINAHL Complete (13), Google scholar (27) and Business Source Complete (3). Additional 10 articles were identified through hand searching. A total of 81 articles were remaining after exact and close match duplicates were removed and 51 records were then excluded after reviewing the titles and abstracts of the articles. Having met the inclusion criteria, 40 full-text articles were thus examined for eligibility, out of which 26 were selected based on the criteria (see Table 1) and used for data extraction and analysis (see Table 2).

Table 1: Inclusion and exclusion criteria

Criteria	Assessment level	Reasons

Inclusion	Full text	Literature in English language
	Abstract	Literature on or after 2009
	Abstract	Literature from all countries
	Title and Journal	Peer reviewed
	Full text	Relevant to the integration of services
Exclusion	Full text	Literature with ethical flaws, inconsistencies of poor design and methodology
	Full text	Literature not in English language
	Full text	Literature unrelated to integrated care models
	Abstract	Literature prior to 2009

The Gap in the Integration of Medical and Dental Services

There have been reports highlighting the mounting prevalence rate of diabetes together with periodontal disease, two diseases linked with bi-directional aggravation (Glurich et al., 2017; Broder et al., 2014; Atchison et al., 2017; Takhar et al., 2016). This inter-relationship between diabetes and dental health therefore necessitates the exploration of integrated care models that involve dental professionals in the management of diabetic patients to improve patient health outcomes. However, globally, medical and dental care systems have historically been siloed due to the disconnect between medical and dental teams in the management of diabetic patients (Poudel et al 2017).

In support of the above finding, Atchison & Weintraub (2017) explain that, historically the integrated approach to healthcare is more common across medical specialties while integrated care between medicine and dentistry was limited to the traditional cross-referral pathways. Glurich et al. (2017) also highlights the limited representation of oral healthcare workers on integrated care teams proposed to provide comprehensive diabetic care delivery globally. More so, Broder et al. (2014) also highlight this lack of integration across the entire healthcare system of a low- to middle-income country. They further opine that this lack of integration is potentiated by the lack of knowledge by some medical staff responsible for treating diabetic patients regarding the need to integrate diabetic care services with dental care.

While the epidemiological evidence reveals the global epidemic prevalence of diabetes, this underlies the need to establish care models that would eliminate the disintegrated manner of health delivery. Also, considering the close oral-systemic relationships, there is the need for integrated care models that involve multidisciplinary care delivery by medical and dental health professionals.

The Concept of Integration

There is a paradigm shift in healthcare delivery from a "paternalistic model" to a more patient-centred model which encourages shared responsibility and decisions in healthcare delivery (Bujan et al., 2015) Indeed, this form of shared health service delivery, a component of an integrated care, is a fundamental principle promoted by numerous scholars (Bogner et al., 2012; Furler et al., 2014; Glurich et al., 2017; Lamster & Myers-Wright, 2017; Marchant, 2012; Marshall et al., 2013; Pope and Truong, 2018; Prestes, Gayarre et al., 2017; Prestes, Sabione et al., 2018; Smits et al., 2019; Takhar et al., 2016).

The general conceptualisation of integration by the articles reviewed reflects a team-based approach. Specifically, terms like multidisciplinary (Bujan et al., 2015; Bick et al., 2014; Glurich et al., 2017), cross disciplinary (Glurich et al., 2017), collaborative (Furler et al., 2014; Lutfiyya et al., 2019; Marchant, 2012; Broder et al., 2014) have all been used to represent integrated care. At the conceptual level, all these categorisations represent essential characteristics of an efficient healthcare service.

Specifically, integrated care is defined as "an approach to overcome care fragmentations, especially where this is leading to an adverse impact on people's care experiences and care outcomes" (Goodwin, 2016, p. 6). Integrated care can also be defined as the "interprofessional collaborative practice when multiple health workers from different professional backgrounds provide comprehensive services by working with patients, their families, careers, and communities to deliver the highest quality of care across settings" (Atchison and Weintraub, 2017, p. 406). These definitions highlight the intricacies of the healthcare sector and the possible challenges that could be encountered by not only failing to conceptualise health service delivery with a collaborative mindset but also the challenges that may accompany the strategies to integrate such services. Expectedly, in practice, integrated care requires an elaborate, multidimensional and multifaceted approach intended to accomplish an array of goals.

Rising Interest in Integrated Care

The premise that there is a need to introduce integrated care management models for diabetic patients is supported by scholarly articles that state that integrated care models would bring the best possible patient health outcomes (Bogner et al., 2012; Furler et al., 2014; Atchison et al., 2017; Broder et al., 2014; Nalliah & Allareddy, 2014; Rogers et al., 2017). These articles, for instance, highlight the increased relationship between oral and systemic health while emphasising the importance of a multidisciplinary approach in diabetic patient care. For instance, Furler et al. (2014) strongly argues that potentially many adverse health outcomes could be evaded by the effective cross-collaboration between healthcare workers, which aids in the appropriate, prompt identification and communication of risk factors.

In summary, present trends in healthcare delivery have stirred the conceptualisation of integrated care with regards to medical and dental services. A key driver is the desire to optimise patient health outcomes and has perhaps justified the need for integration of dental care into diabetic patient management, while providing frameworks and case studies to guide the integration process. This is contrary to happenings in some health systems that lack any form of integration between these services, whereby patients lack any support while seeking appropriate care across the clinics. Therefore, this emphasis on the strategies for integration of these services is reinforced by ethical and moral concerns about the outcomes of the delivery of healthcare services.

Overview of Integrated Care Models

The integration of medical and dental services can be done in numerous ways. These variations can be characterised as a continuum from segregation to co-location as reflected in most conceptual models (Atchison et al., 2017). However, integrated care in the models discussed below will take into consideration the need for service integration across all levels of the health system. This framework will serve as a foundation for considerations of the integration practices as a whole while emphasising the medical and dental integration.

There are over 20 instances of integration of medical and dental services in the reviewed literature which span from sharable clinical notes summary, the addition of an oral health professional to a medical team, raising awareness of patients and staff through printed educational resources and other forms of multimedia to provide education or training (e.g. Broder et al., 2014; Atchison et

al., 2017; Glurich et al., 2017). These integrated care models were undertaken in a variety of clinical settings, different durations and among different age groups. Also, while some integrated care models are clearly named in the studies, others are somewhat described without any identifiable name.

Regarding the scope of the interventions considered, a few articles described in detail the development and implementation of only one integrated service (e.g. staff education by Marchant, 2012). Other articles also highlighted the ways of designing a holistic approach in the conduct of an integrated programme (e.g. Hummel et al., 2015). Furthermore, other articles discussed programs with the aim of collating operational lessons from the gaps in other integrated pathways implemented by some organisations (e.g. Glurich et al., 2017). Nevertheless, all these models could serve the purpose of educating policymakers, international health organisations, professional groups, health managers and other interested stakeholders about the best practices for integrating dental and general patient care.

Looking at specific examples, one model involves the appointment of an integrated care manager who coordinated the management of patients by offering education and guidelines that enabled clinicians across services to track patient compliance and their clinical status (Bogner et al., 2012). Alternatively, another integrated care model in the management of pregnant women with diabetes involved educating health professionals by specialists about the need for multidisciplinary teams in the management of their patients (Bick et al., 2014). Although the outcomes of integration for these models are quite similar, the major disparity is the absence of designated integrated care manager in the latter model. A key drawback for these integrated models is their sole reliance on human elements while disregarding other health system elements such as the financing mechanisms for both medical and dental services.

Bujan et al., (2015) also discusses an integrated care model dubbed “the EPPC” which involved a multidisciplinary initiative involving an Expert Patient who takes a lead role in disseminating information regarding their experiences with diseases shared with other patients. This model differs significantly from the models discussed above as the healthcare professionals in this model function as mere observers, and only intervene if necessary. With this model relying solely on the use of an expert patient, it provides operational difficulties in areas where patients refuse to assume such a role. A chronic care integrated care model was also reported with the integrated care

provided for diabetic patients by the Marshfield Clinic system in Wisconsin being a clear example (Glurich et al., 2013). This model primarily involved an integrated Electronic Health Records (EHR) system with other forms of quality metrics visible to both medical and dental teams. Having diabetes and periodontal registry could help provide clinical parameters necessary for the management of diabetes and periodontal disease, which could improve the process of disease management and quality of care. However, the narrow focus on the integration of the electronic health records limits its applications to settings that use electronic health records, especially as some hospitals within low- to middle-income countries are yet to adopt this health recording system.

The model proposed by Preshaw & Bissett (2013) recommends the use of dental hygienists to institute behavioral changes among diabetic patients. This close collaboration between dental hygienists and physicians would have a positive impact on the management of diabetic patients. This model is quite similar to the Interdisciplinary Care team model proposed by Shimpi, et al., (2019). The difference is that the model proposed by Shimpi et al. (2019) consists of a wider interdisciplinary care team, which comprises of Medical providers, Dental providers including dentists, dental hygienists, Diabetes educators, Nurse practitioners, Pharmacist, Social Worker and Nutritionist. Unlike the chronic care model previously discussed, these models do not make mention of the integration of the patient health records, which is a critical component for good quality patient care.

The Rainbow-Modified Integrated Care model reviewed by Atchsion et al., (2017) considers four dimensions of integrated care that that integrates healthcare at the macro level (health system), meso level (organisational and/or professional), micro level (clinics within an organisation) and an added dimension which consist of the functional and normative level. The macro level integration involves the interconnection of health services within a health system through policy while the meso level integration involves integration of professional roles and/or inter-organisational collaborations. Micro level integration on the other hand involves the co-ordination for specific patient care. The functional integration involves the coordination of support services such as IT services across all levels while the normative integration integrates the culture and values, also across all levels.

Table 2: Data Extraction Table

AUTHOR'S NAME	STUDY TYPE	OUTCOMES	COMMENTS
Broder et al. (2014)	Qualitative study involving focus group discussions	Over half of the focus group participants displayed some knowledge regarding common oral health issues such as bleeding gums, tooth sensitivity etc. Despite this knowledge, several participants stated they had never visited a dentist. Furthermore, most focus group participants did not know of the association between dental health and diabetes and therefore saw no need to periodically visit the dentist.	The use of convenience sampling limits the generalisability of the findings. Additionally, the oral health history provided by the focus group participants was not validated with any form of clinical data, thereby necessitating further research into the indicated population.
Atchison and Weintraub (2017)	Invited commentary	This study highlights the different form of integration that could underpin the process of integration between dental and medical teams. Some of these include an official closed-ended referral pathway, common financing systems, co-location of medical and dental providers etc.	This standalone commentary provided a balanced overview of the subject material while providing the expert author's personal opinions of and insight into the matter of integrated care between medical and dental teams. It had a clear take home message that advocated for the integration of such services.
Rogers et al. (2017)	Prospective cohort study	The significance of this study is to introduce a new healthcare model that integrates medical and dental services through the testing of blood sugar at the dental clinic. 68% of participants tested had were discovered to have either: 1. Previously diagnosed diabetes 2. Being investigated by their general GPs for aberrant blood sugar levels or 3. Were categorised as high-risk based on the AUSDRISK assessment tool.	This study highlights a model of care that involves a medical-dental integration which indeed led to an improvement in the health outcomes of patients. There is an appealing simplicity about this model, however, the scope of this study did not enable the comprehensive measurement of the accomplishments.
Nalliah & Allareddy (2014)	Descriptive study	400,000 Emergency Room visits were made in one year in the US due to dental diseases with hospital charges amounting to $163 million. Also, 20 E.R dental disease-related mortalities were reported to have occurred in the US in 2008. This data coupled with the consideration of the largely siloed dental care system in the US formed the basis for the authors' argument that dental services should be integrated with medical services.	This article explores the burden of dental diseases and medical diseases exacerbated by the neglect of one's oral health. It also proffers reasons seeking to integrate dental and medical services to reduce the burden of these diseases. This adds to the knowledge base about the importance of restructuring hospitals to integrate oral health professionals into the mainstream hospital team.
Atchison et al. (2017)	Commissioned report	Among the integration programs examined in this report, there were 37 programs whereby primary oral health screening was provided by physicians, to both children and pregnant women. Also, in 16 instances, preventive oral health services were provided by oral health professionals workers in nontraditional settings such	In response to the mounting calls for the integration of medical and dental services as an approach to improve patient outcomes, this commissioned report, underpinned by an environmental scan, explored ways to encourage effective integration between primary care and dental health. This represents a comprehensive

		as GP clinics, community health settings, and schools. Furthermore, there were 22 examples demonstrating integration of individual cases whereby patients were directed to a dental home for further care. Lastly, despite the fact that this was not the primary aim of the environmental analysis, 16 instances of integrated care were found where dentists provided basic systemic health screening with further referral of patients if needed.	review that ultimately backed the claims for more integration between dental and medical teams.
Glurich et al. (2018)	Qualitative study involving focus group discussions	A total number of 40 individuals, that is, 23 medical and 17 dental healthcare workers participated in the focus group discussions. Some of the barriers that hindered the integration of medical and dental services as discussed at the focus group discussion include the absence of standardised communication channels between the two clinics, lack of awareness about the oral systemic link, lack of cooperation from patients, the insurance status of the patients, privacy, security and compliance complaints among other issues. Overall, some of the recommendations proffered to address these challenges include the introduction of oral health educators within the medical clinic and the reintegration of dental services into medicine as a specialty.	Although only four focus group discussions were held, there seems to be an achievement of thematic saturation with central themes successfully identified. However, because the participants were voluntarily self-selected, confounding influences such as experiential biases associated with their setting could not be ruled out.
Glurich et al. (2013)	Descriptive study (Invited Medical review)	This study describes a personalised medicine model at Marshfield Clinic that integrates diabetic and oral care to improve health outcomes of diabetic patients. Specifically, it involved the realignment of key resources such as include the iEHR, iEDW, PMRP and an ultra-modern dental clinic infrastructure to advance the understanding of the oral-systemic connection and contribute further to developing personalised approaches. The key drivers for the medical-dental integration at Marshfield Clinic are the: combined dental and medical infrastructure, the integrated electronic health records and the research infrastructure that facilitated research into the oral-systemic link.	This review provided comprehensive and detailed analysis about the need to integrate medical and dental services. Importantly, this article highlighted the social, emotional and physiological importance of diabetes and oral health individually before arguing for their integration to improve health outcomes. Regrettably, the claim that collateral benefits were harnessed through the use of multidisciplinary approach was not backed by empirical evidence, and this represents a major limitation.
Poudel et al. (2017)	Systematic review	This study undertook a systematic search of 5 databases in search of evidence both at the global and local level on the oral health knowledge of health professionals providing diabetic services and the function that medical professionals outside dentistry can perform in the promotion of oral health services. The oral health knowledge among such providers was however found to be low. Nevertheless, it was also shown that the training of non-dental staff such as diabetic nurses could make them competent enough to undertake oral health promotion initiatives.	The findings of this systematic review reflect findings from other literature that highlight the historically siloed medical and dental care teams. It also presents a viable solution that involves increasing oral health awareness among non-dental health professionals. However, in agreement with the authors, although Diabetic Educators are rightly equipped to take lead roles in oral health promotion at diabetic centres, there is a need for further research to determine how to continuously improve the services rendered by them.

Bick et al. (2014)	Systematic review	This study involves a systematic search of evidence of efficacy of multidisciplinary team models of care providing care to pregnant and breastfeeding women chronic diseases such as heart diseases and diabetes. None of the studies considered critically evaluated the multidisciplinary models against each other. However, when compared to non-integrated models, the multidisciplinary models were shown to lead to better patient health outcomes.	The findings of review provide contrasting views regarding the importance of integrating maternal and diabetic services. While some studies highlight their importance, the authors conclude despite the consensus support for the multidisciplinary care, there is a dearth of evidence supporting its role in clinical practice. This is in sharp contrast to other studies that recommend the integration of services to optimise patient health outcomes. Nevertheless, despite the seeming paucity of evidence underpinning the integration of such services, further research is needed establish the veracity of this claim.
Furler et al. (2014)	Randomised control Trial	The stepping up trial which involves a General Practitioner and a Practice Nurse supported by other care professionals. This multidisciplinary care model was hypothesised to improve diabetic patient health outcomes as was shown to reduce HbA1c measurement of <7.0%. Furthermore, there is an expectation of cost savings as a result of the reduction of potential complications from diabetes.	This study is a pragmatic translation which has important implications not only for diabetic patients but also health professionals. Though specifically targeted at the Australian population, the findings can be locally adapted and applied to other countries.
Danquah et al. (2012)	Empirical study	75% of the 1,536 recruited diabetic patients were females. Also, diabetes was found to predominantly affect obese patients of low socio-economic status. Furthermore, diabetes was commonly found to be associated with hypertension and hyperlipidemia.	This hospital-based empirical study was aimed at characterising "clinical, anthropometric, socio-economic, nutritional and behavioural parameters" of typed 2 diabetic patients while identifying related factors. However, the use of a convenience sampling technique limits the generalisability of the research findings. Notwithstanding this limitation, the findings are consistent with other studies considered the characteristics of diabetic patients.
Takhar et al. (2016)	Empirical study	The research findings show that a high number of diabetic patients do not have access to dental, optometry or pharmacy advice during the course of their treatment. This was attributed to the lack of knowledge among diabetic patients about the need to utilise such services.	The small sample size and the use of convenience sampling of patients from specific sites in Northamptonshire affects the generalisability of the research findings.
Bujan et al. (2015)	Descriptive study	The Expert Patient Program Catalonia (EPPC), an integrated program aimed at helping people take responsibility for the health. This program which lasted over two months was shown to improve knowledge, patient satisfaction and led to behavioral change.	This study highlights the importance of peer learning in integrated services which helps maintain active participation from members in the peer group
Lamster & Myers-Wright (2017)	Descriptive study	This study advocates for the expansion of the scope of dental practice to accommodate the expanding knowledge base on dental-medicine integrated services. For instance, it recommends the screening of patients for dysglycemia in the dental office.	This study agrees with other research findings that the provision of integrated services positively impacts patient health outcomes. It also highlights the need for cross professional collaboration in health education

Bogner et al. (2012)	Randomised control Trial (RCT)	The study involved an RCT in which 180 patients with both depression and diabetes at a primary health center. Patients who partook of this integrated service were shown to have good glycemic control (less than 7%).	This corroborates other findings that the provision of integrated services optimises patient health outcomes.
Marchant (2012)	Descriptive study	This study describes a staff education program which helped improve the knowledge base of a member of the multidisciplinary team providing diabetic care. This inadvertently led to improvement in patient glycemic control.	A major limitation of this study, also acknowledged by the authors, is the restriction of the training program to just one member of the multidisciplinary team providing diabetic care. Nevertheless, this pilot has laid foundation for the development of strategies that emphasise the need for service improvement programs involving integrated care.
Marshall et al. (2013)	Descriptive study	This describes the ElderSmile Clinical program in which 775 adults aged over 50 years who underwent Oral Health education. A questionnaire survey was then taken after which they subsequently screened for HBA1c and Blood pressure. Generally, it was found out that there were low self-reported levels of poor oral health and general health.	The finding that adults with oral health problems had concomitant systemic health problems agrees with other studies considered. This therefore necessitates the integration of oral and medical health services. However, the perceived experimenter bias on the part of the scholars, due to the conscious and unconscious influences of their association with the program perhaps affects the validity of the results.
Pope & Truong (2018)	Descriptive study	This study describes an integrated care service provided by Primary Healthcare Limited that attends to approximately 2 million patients annually. This involved the training of chronic care coordinators who managed the integrated services. The integration ultimately led to better patient health outcomes.	This study is consistent with other studies that state that the integration of health services leads to better patient health outcomes. A key limitation on the part of this study is the inability to provide any justification of evidential value regarding the efficacy of this integrated model. Moreover, there was a gross disregard of an important part of any project; the evaluation process. Nevertheless, this limitation represents a shortcoming on the part of the authors, and not an indication that such as integration is not attainable.
Prestes, Gayarre et al. (2017)	Descriptive study	This study describes the DIAPREM programme, an integrated diabetes care programme that helped patients improve health outcomes in diabetes and hypertension.	This study practicalizes the concept of integrated care while showing the benefits that can be gained from integrating health services. However, the determination of causality is hindered by the use of data retrospectively.
Prestes, Sabione et al. (2018)	Observational study	This study compared the health outcomes of patients partaking in an integrated diabetic care service to those partaking in specialised services. The study showed that patients undertaking the integrated care comparatively had low levels of creatinine, HBA1c and thus were on few diabetic medications.	This study agrees with other studies that integrated diabetic services represent an effective and efficient manner to achieve good patient health outcomes. However, the inability to evaluate outcomes such a mortality and access to the services represents a shortcoming.
Smits et al. (2019)	Empirical study	This study highlights the development of a survey used to assess patient's perception on the efficacy of an integrated health service. This yielded in thirteen questions for inclusion in the ICRP survey	The findings from this research will greatly impact the evaluative processes that guide the evaluation of integrated health services. The failure to involve patients who are key

			stakeholders in the development of the survey represents a major limitation.
Lutfiyya et al. (2019)	Systematic review	Out of the 375 articles reviewed, the most common professions that had collaborations between them were nurses, physicians and pharmacists. The primary care setting was also the most commonly used setting for integrated practice.	This study confirms the view that integration between medicine and dentistry still has room for improvement. Indeed, dentistry was not found to be one of the professions that collaborates with other professionals.
Hummel et al. (2015)	Descriptive study	This study highlights a myriad of ways of integrating oral health into general health services. One of which is the oral health delivery framework that educates health care givers to provide oral health education to patients seeking care at other departments.	This agrees with other studies that increasing oral health education can positively impact the consumption of health. Indeed, health literacy is considered to be a critical component of integrated services.
Miller & Bauman (2014)	Descriptive study	This review identifies that collective goal setting empowers patients to undergo behavior change aimed at optimising health outcomes.	In spite of the seemingly logical recommendation that the use of share goal setting between patients and health workers could lead to patient compliance, it is still needful to conduct a systematic and comprehensive study to examine the conditions under which shared goal setting is likely to achieve its intended goals.
Preshaw & Bissett (2013)	Descriptive study	This study analyses the manner in which periodontitis occurs as a complication of diabetes. It also briefly describes an integrated care model that involves the collaboration of dental hygienists and the medical team responsible for treating diabetic patients.	This study agrees with the large number of epidemiological studies that argue that a closer integration of dental and medical teams is needed to improve the health outcomes of diabetic patients.
Shimpi et al. (2019)	Descriptive study	This study describes an Interdisciplinary Care Model for Diabetes and Oral Health following a comprehensive analysis of the interrelationship between diabetes and periodontitis.	This study reinforces the need to provide integrated diabetic and dental care services through diverse means such as an increase in the focus of dental education amongst medical students which will help in increasing quality of care

In summary, the interest in the integration of medical and dental care has indeed increased, with an apparent unifying framework based on the premise of improvement in patient health outcomes. Common among the integration efforts in oral health is the consideration of the role of health literacy in integration which is one of the principal competency spheres in integrated care (Marchant, 2012; Broder et al., 2012; Atchison et al., 2017). Also, integrated care models that do not take into consideration wider health system elements such as the training systems, governance mechanisms and financing systems do not seem to address the key requirements by health systems especially in low- to middle-income countries. This means that, the integrated care models that are narrowly focused may not be very useful for the health systems considered because the integrated care provided will be limited to only some components of the health systems.

Discussion

A Suitable Integration Model for the Healthcare Systems in low- to middle-income countries

The World Health Organisation has over time supported the partnership of healthcare services in order to optimise health outcomes with rising interest and increased attention which has empowered many groups to embark on actions that enable the integration of medical and dental services (WHO, 2007). The differences in the health systems globally led to the examination of attributes that are regarded 'essential to integration of dentistry into medical care' in the low- to middle-income countries. The identified Rainbow Model of Integrated Care (RMIC) should thus be locally adapted to reflect the local context of health delivery in these countries. This modification is based on reports in the wide literature on the topic, that reveal other models which also captured some of the truth and therefore their dimensions could be modified and added to the chosen model to ensure the realisation of the intended goals. Overall, the chosen integrated care model should therefore be able to comprehensively address the gaps in knowledge, attitude and behaviors amongst both the healthcare providers and patients across all levels of the health system.

Using the RE-AIM Framework to evaluate the impact of the RMIC model

The literature on service integration has provided different tools for evaluating integrated care models such as the RMIC model. Some of these include the network matrix, micro assessment tool, RE-AIM Framework and many others (Bautista et al., 2016; Fares et al., 2019). Although these studies affirm that none of these measurements can capture all of the dimensions of

integration contained within the RMIC, the RE-AIM (reach, effectiveness, adoption, implementation, maintenance) Framework has been chosen for use in this study because it primarily focuses on assessing evaluating health interventions that consider the dynamism of human behavior (King, Glasgow & Leeman-Castillo, 2010). Given the importance of human behavior to the introduction of any service improvement model, it seems logical to use RE-AIM to evaluate the dimensions of RMIC service integration approach.

Reach*:* There are about 336 million people with diabetes in low- and middle-income countries (Dunachie & Chamnan, 2019). In sub-Saharan Africa, the growth rate of DM is among the highest globally with a prevalence rate of 4%, representing about 12 million individuals and this is projected to double over a 20-year period (Danquah et al., 2012, p. 1). Therefore, the growing diabetes epidemic has triggered responses, some of which have resulted in a paradigm shift, where management models such as the RMIC that are proven to be efficacious in reducing the disease burden are continuously being examined and proposed for adoption (Glurich et al., 2018).

Effectiveness: Service integration often involves a complex set of unpredictable processes that interconnect at multiple levels. This means that, developing an integrated care service will typically require a sophisticated change strategy that considers the multiple levels of integration. The RMIC as discussed previously addresses the different dimensions and domains of integration at the systems, professional, organisational and clinical levels. This is particularly important in some low- to middle-income countries whose health systems are often disease-oriented (Druetz, 2018). This cross functional approach is intrinsically cohesive as a result of its comprehensive nature and could help overcome the tensions that may exist between the system level integration and the integration at the lower levels. This model which underpins the basic tenets of primary care also focuses on providing both patient-centered care and population-based care and provides a comprehensive conceptualization of integrated care (Nurjono et al., 2016; Fares et al., 2019).

Adoption: The Rainbow Model of Integrated Care (RMIC) was praised for the consideration of a wider range of influences regarding integration such as professional and organisational structures on the health system in comparison to other models (Atchison et al., 2017). They further explain that the recognition of these influences enables the integration of health services at different levels to facilitate their comprehensive coordination. For instance, it assigns health literacy interventions at each integration level. This reflects the view that increasing oral health knowledge among

patients and health professionals is more likely to have a positive effect and this highlights the need to consider all key stakeholders at different levels (Broder et al., 2014). It is significant because oral health information is neither obtained nor disseminated at most diabetic centres in low- to middle-income countries. However, an analysis of this model shows that, although the continuum of integration that underpins other integrative models is obvious here, the emphasis is more focused on systems. Nevertheless, the RMIC model is recommended as it is feasible and would serve as a helpful guide to the implementation of the integrative strategies (Atchison et al., 2017).

This model also aligns with the current dental care delivery system in most low- to middle-income countries which have a limited integration anchor (Broder et al., 2014). Indeed, the RMIC model which involves integration at the clinical, professional, organisational and system levels seems to be a more holistic approach to medical-dental integration as it recognises all these health system elements. More so, the RMIC model specifies the core consumers of the integrated services and the extent to which the services can be integrated. This would enable the measurement and analysis of the efficacy of the integrated model. Furthermore, the recognition of health literacy as a focus for the integration process directly addresses the limited knowledge of non-dental health professionals and patients with regards to the benefits of introducing this integration model.

Implementation and Maintenance: This RMIC model must be adjusted to local situational factors in order to fully harness the benefits of integration within these healthcare systems. For example, the differences in the financing systems for dental and medical services across hospitals in the low- to middle-income countries ought to lead to local adaptation of the integrated model. This can be done by raising awareness about the benefits of diabetic patients seeking dental care which may encourage the patients to pay for such services out-of-pocket in these countries.

The modification of this model also considers the fact that raising awareness alone would not be an effective intervention in the management of diabetic patients; rather a more patient-centred approach that involves collaboration between the patient and health professional in all decision-making processes is more likely to lead to patient compliance (Miller and Bauman, 2014). They further explain that diabetic patients who collaborated with a health professional in developing personalised healthcare goals have indeed proven to have better diabetic health outcomes. This modified model, therefore, provides a means of filling the current integrative between the diabetic

and dental care within these healthcare systems with a potential framework for the provision of an appropriate degree of service integration.

Conclusion and Practical Implications

This study summarises evidence on the integration of medical and dental services to improve the health outcomes of diabetic patients. Specifically, it examined the scope of the burden of diabetes with gaps in diabetic patient care identified globally. This global problem is reflected in some low and middle-income countries, thereby necessitating the exploration of service integration models that will optimise patient health outcomes and help reduce the disease burden. The reviewed literature identified a clear gap in the integration of diabetic and dental care. This gap reflects the historically siloed medical and dental services which need to be bridged to enable the provision of more comprehensive diabetic patient care. Several studies have therefore identified the need to implement integrated care in order to improve patient outcomes, with myriad ways of care integration.

Periodontitis, an oral disease, has been identified as a modifiable risk factor which when addressed could greatly improve the outcomes of diabetic patient care. This lends credence to the need to introduce an integrated care model involving both medical and dental teams in the treatment of diabetic patients. This approach is supported by scholarly findings from the various integrated care models explored. After a careful evaluation of the models, the Rainbow Model of Integrated Care (RMIC) was identified as a model with the potential to address the core needs of the local context of the hospitals, especially in resource poor setting.

Although the integration of dental and medical services has been proven to be useful in improving diabetic patient outcomes, the limited knowledge about these proven benefits has been identified as the main reason hampering the integration of these services. Hence, the application of the RMIC model should be modified to involve a contemporary awareness programme targeting both staff and patients at all levels at diabetic care centres, There is also the need for the introduction of a referral pathway to enhance cross-collaboration in the treatment of the diabetic patients and the involvement of a collaborative decision making between patients and health professionals to maximise patient compliance.

There is an expectation of cost savings through the downstream decrease of diabetes-associated complications, especially when many diabetic patients do not maintain adequate glycemic control. More so, basic periodontal therapy is paid for by some health insurance payment systems which is a clear indication of cost savings for the patient and other stakeholders. Therefore, in the short, medium and long term, the integration of diabetic and dental care using the RMIC would lead to cost savings on the part of the patient and healthcare systems in resource poor settings, and this is underpinned by particularly substantial evidence. Other benefits include positive patients' outcome, time saving, preventive and population health benefits and good quality of life. Therefore, there is the need to formulate policies that seek to address integration gap especially in the healthcare systems of most low- to middle-income countries. But key to this is the need to ensure a sustainable health financing system that provides for both diabetic and basic periodontal care. A follow-on study to show how the results of this study could impact the design and implementation of a service improvement initiative in a low- to middle-income country is needed to evaluation how well it worked in practice.

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